



## “Heat Island Mitigation Measures in Response to Climate Change Impacts”

**Dale A. Quattrochi, NASA Marshall Space Flight Center,  
Huntsville, AL**

**Maurice Estes, Jr., Universities Space Research  
Association, National Space Science &  
Technology Center, Huntsville, AL**

**William Crosson, Universities Space Research  
Association, National Space Science &  
Technology Center, Huntsville, AL**

**Mohammad Al-Hamdan, Universities Space Research  
Association, National Space Science &  
Technology Center, Huntsville, AL**



# Urban Climate: Local, Regional & Global Impacts

- Charles Abrams, in his book *The City is the Frontier*, wrote: "A city...is the pulsating product of the human hand and mind, reflecting man's history, his struggle for freedom, creativity, genius, and his selfishness and errors."
- Cities have been viewed from a wide range of perspectives as representative examples of the "best" and "worst" of human creativity and selfishness
- On one hand, cities are monuments to human ingenuity -- feats of highly complex engineering and an overall display of the human spirit to build order out of the natural environment
- On the other, cities are the most demonstrable example of how humans have polluted the environment and have willingly and rampantly despoiled nature beyond any sense of reason



- A new "paradigm" in urban planning and in how we view cities is emerging
- We are beginning to embrace the principles and techniques of *sustainability* and *sustainable development* in planning and managing cities
- We are looking at how livable cities are for ourselves, our children, and future progeny





- **Sustainable development provides a framework under which communities can use resources efficiently, create efficient infrastructures, protect and enhance quality of life, and create new businesses to strengthen their economies**
- **Where "traditional" approaches can lead to congestion, sprawl, pollution, and resource overconsumption, sustainable development offers real, lasting solutions that will strengthen our future**



***NASA's Earth Science and Applied  
Programs Target Questions Where Human  
Impacts and Urbanization are Strategic  
Components:***

- **How is the Earth changing and what are the consequences for life on Earth?**
- **How is the global Earth system changing?**
- **What are the primary causes of change in the Earth system?**
- **How does the Earth system respond to natural and human-induced changes?**
- **What are the consequences of change in the Earth system for human civilization?**
- **How well can we predict future changes in the Earth system?**
- **Earth Science Applications: Turn scientific and technical capabilities into practical tools for solving real world problems**

# NASA Applied Sciences Program National Applications:

- [Agriculture](#)
- [Air Quality](#)
- [Ecological Forecasting](#)
- [Natural Disasters](#)
- [Public Health](#)
- [Water Resources](#)
- [Weather](#)

## Urbanization and NASA Earth Science and Applications

- The 21<sup>st</sup> century is the first urban century in the history of humankind
- Current projections are suggest that 60-80% of the world population will live in urban settlements by the end of this century
- Across the globe, more than 411 cities have more than one million inhabitants
- In the 1970's the United Nations defined cities of 10 milliion or more residents as "megacities"
- In 1975 there were five megacities around the world
- Today there are 19+, and by 2015 the number of megacities is expected to grow to 23







## Urbanization Impacts

The built environment alters surface fluxes of heat, water and carbon and so interacts with climate, weather and energy cycles with feedbacks that influence human health, energy consumption, and sustainable economic investment.

- Increases Surface Runoff
- Reduces Carbon Sequestration
- Alters Energy Balance



# Urban Climate: Local, Regional & Global Impacts

NASA's Remote Sensing Capabilities are Critical and Integral to the Study of Urban Areas and Their Effects on the Local, Regional and Global Environment

Washington, DC  
from NASA  
satellite data

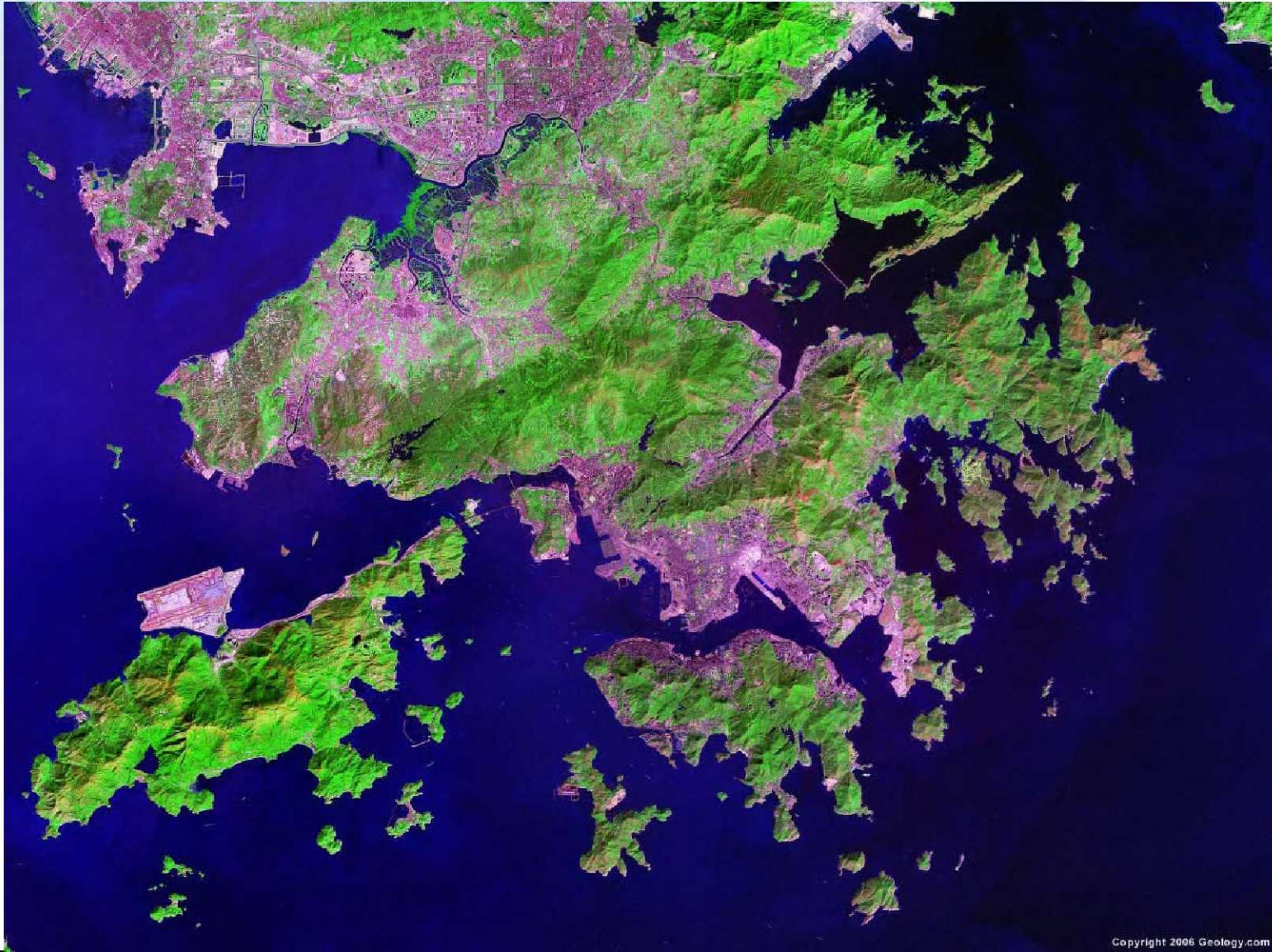






# Urban Climate: Local, Regional & Global Impacts

## Hong Kong

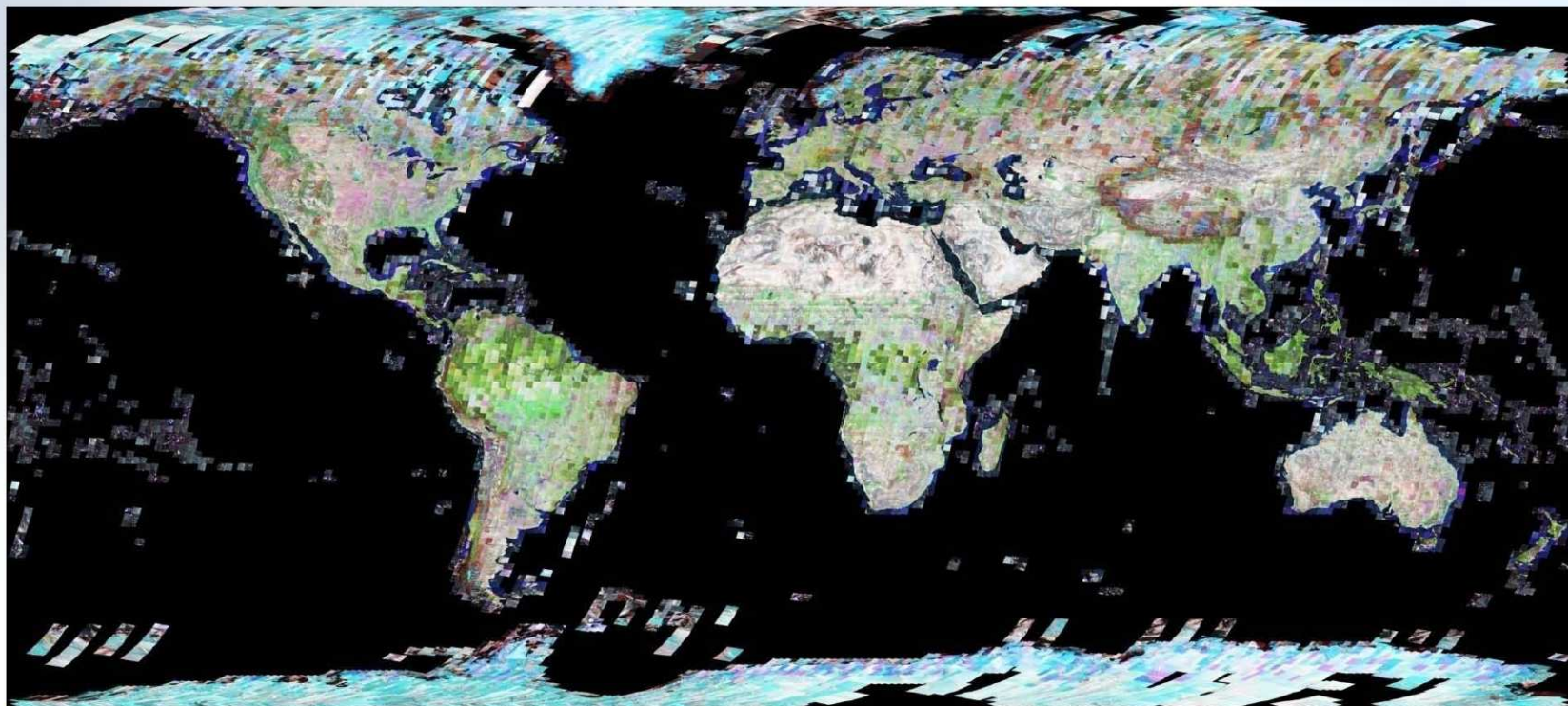






# Urban Climate: Local, Regional & Global Impacts

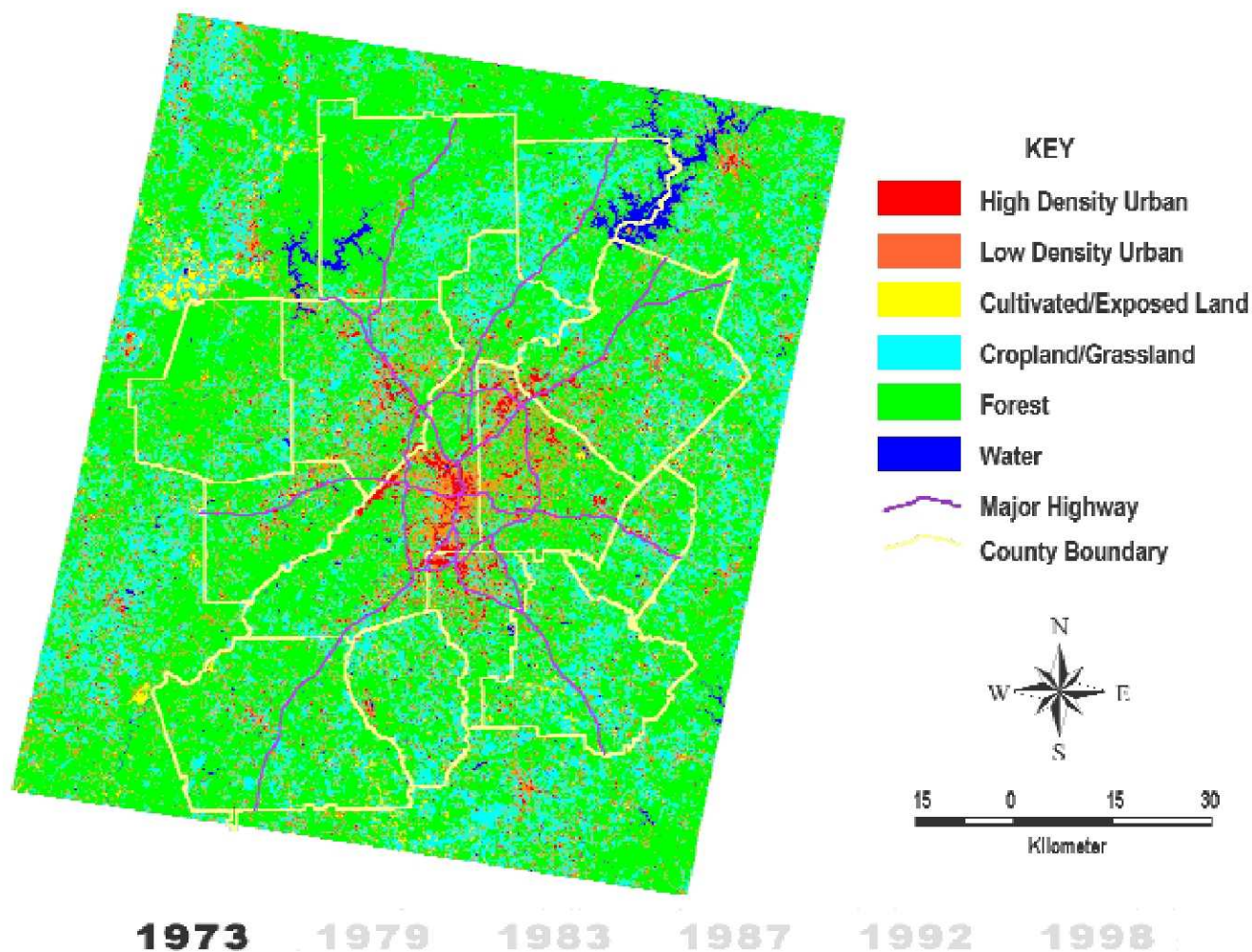
## Landsat World Composite Image - 2001





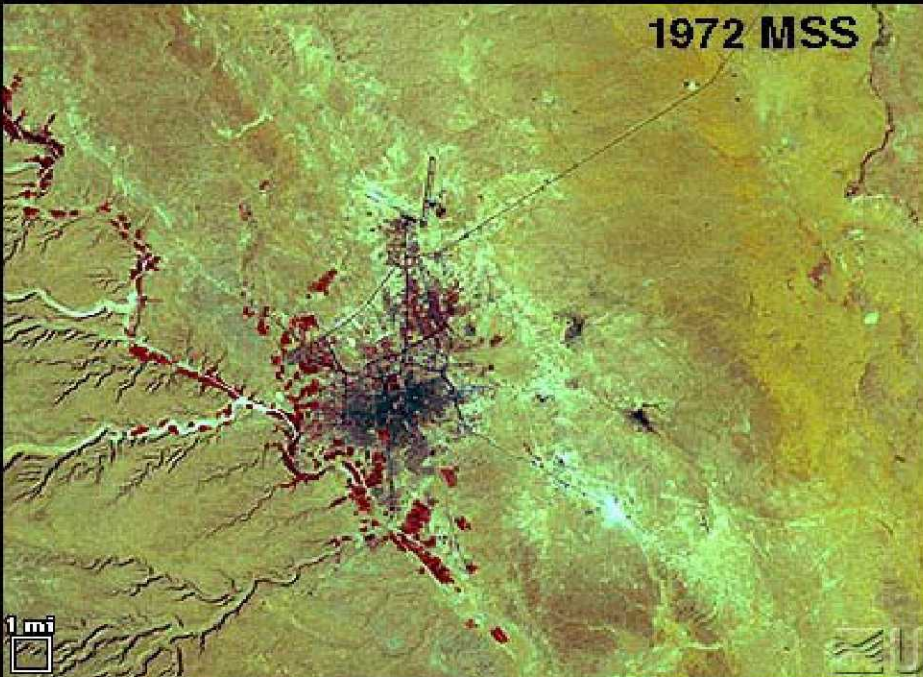
# Urban Climate: Local, Regional & Global Impacts

## Changes in Land Use/Cover, Atlanta: 1973-1998

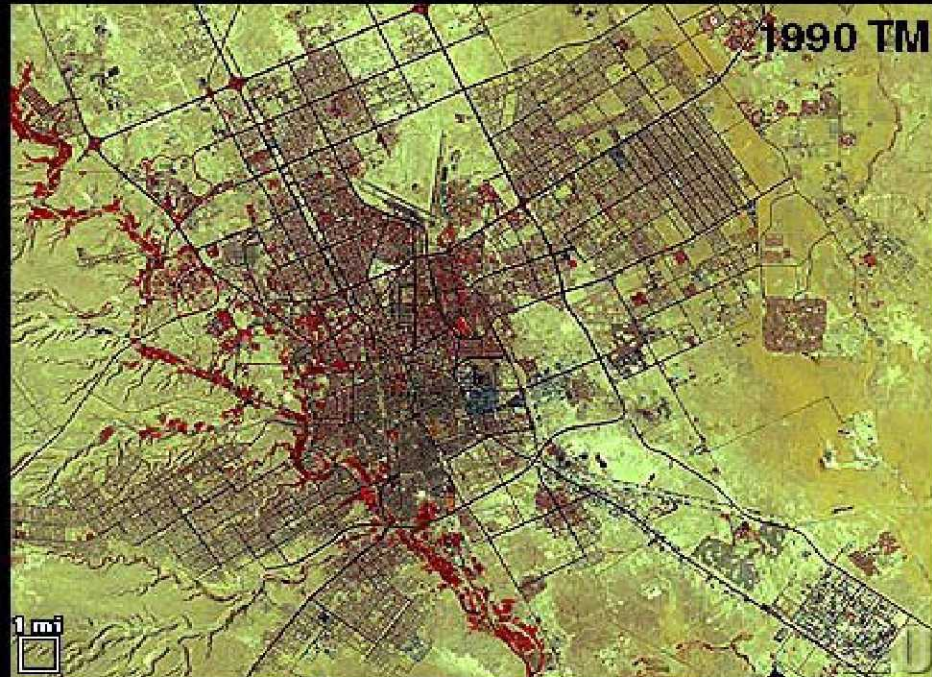




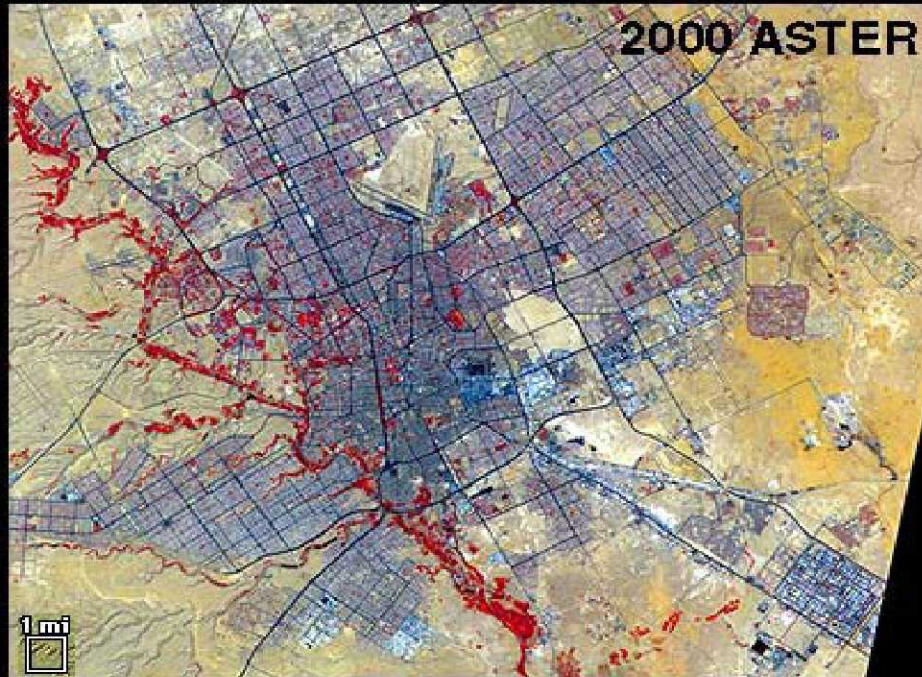
1972 MSS



1990 TM



2000 ASTER



Riyadh, Saudi Arabia showing spatial resolutions of different satellites



# 1986



0 2.5 5 10 Km

□ *Land Processes Group, NASA Marshall Space Flight Center, Huntsville, AL*





# 2007

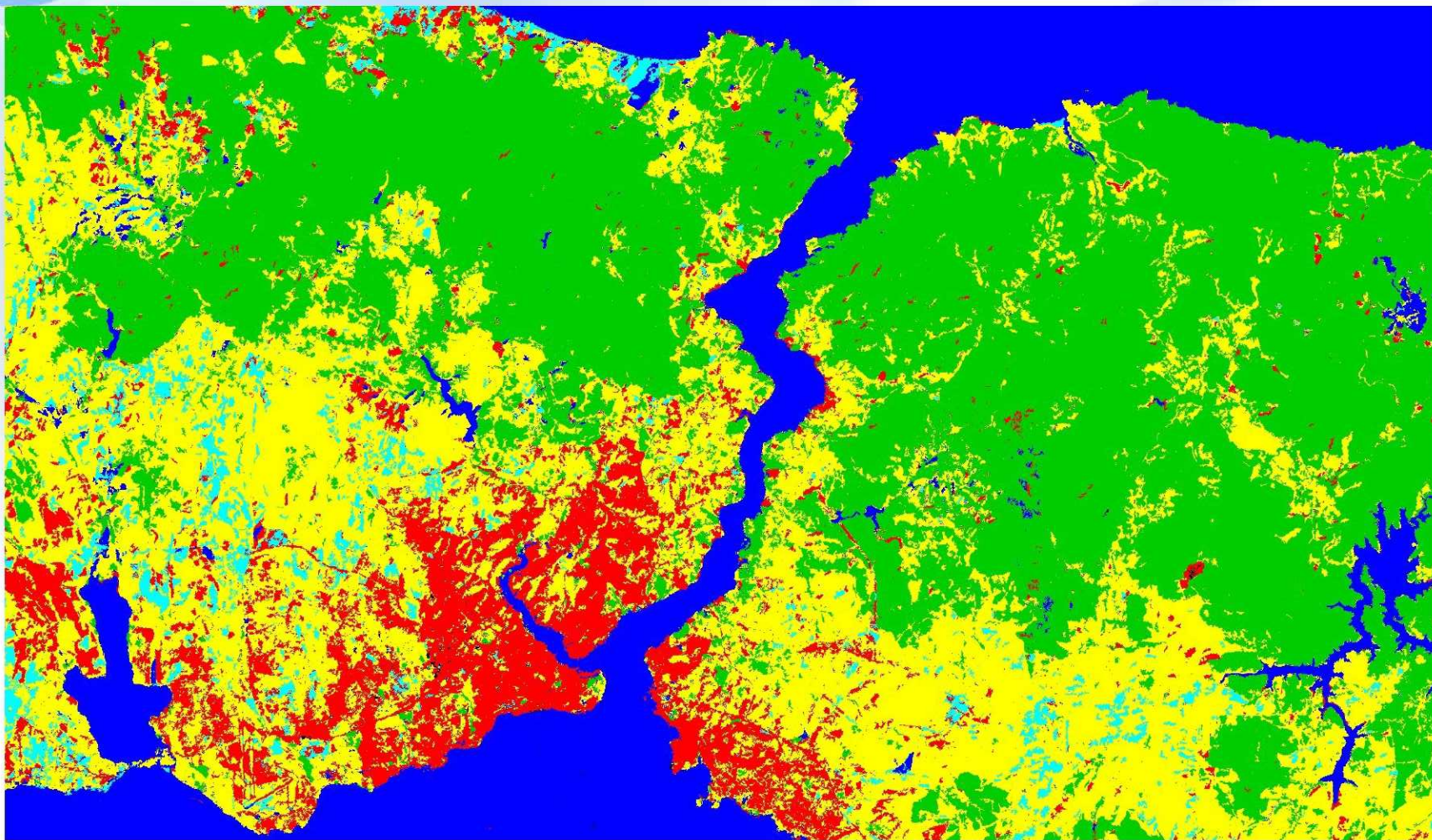


□ *Land Processes Group, NASA Marshall Space Flight Center, Huntsville, AL*





# 1986



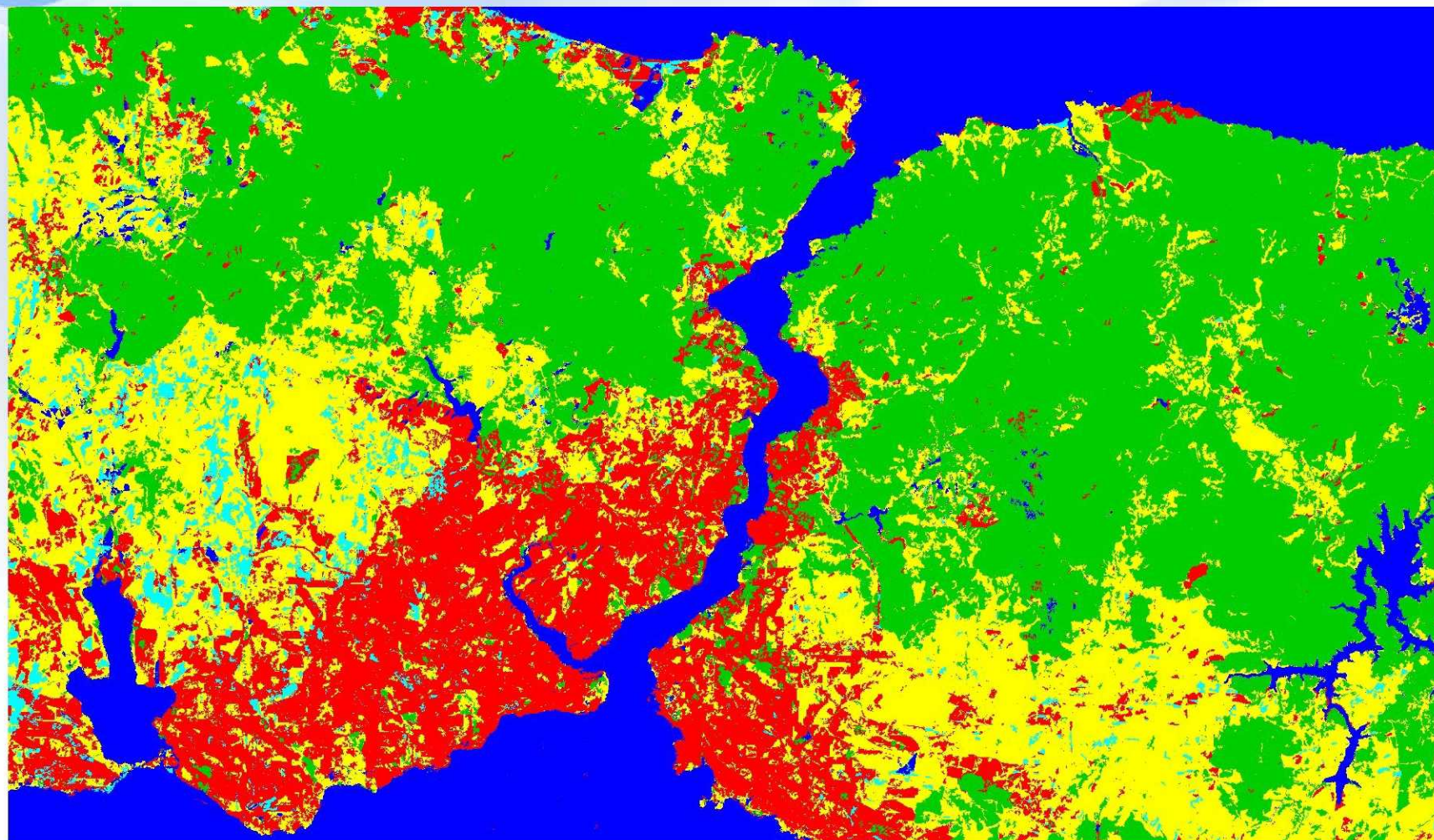
□ *Land Processes Group, NASA Marshall Space Flight Center, Huntsville, AL*







# 2007



□ *Land Processes Group, NASA Marshall Space Flight Center, Huntsville, AL*





# Urban Climate: Local, Regional & Global Impacts

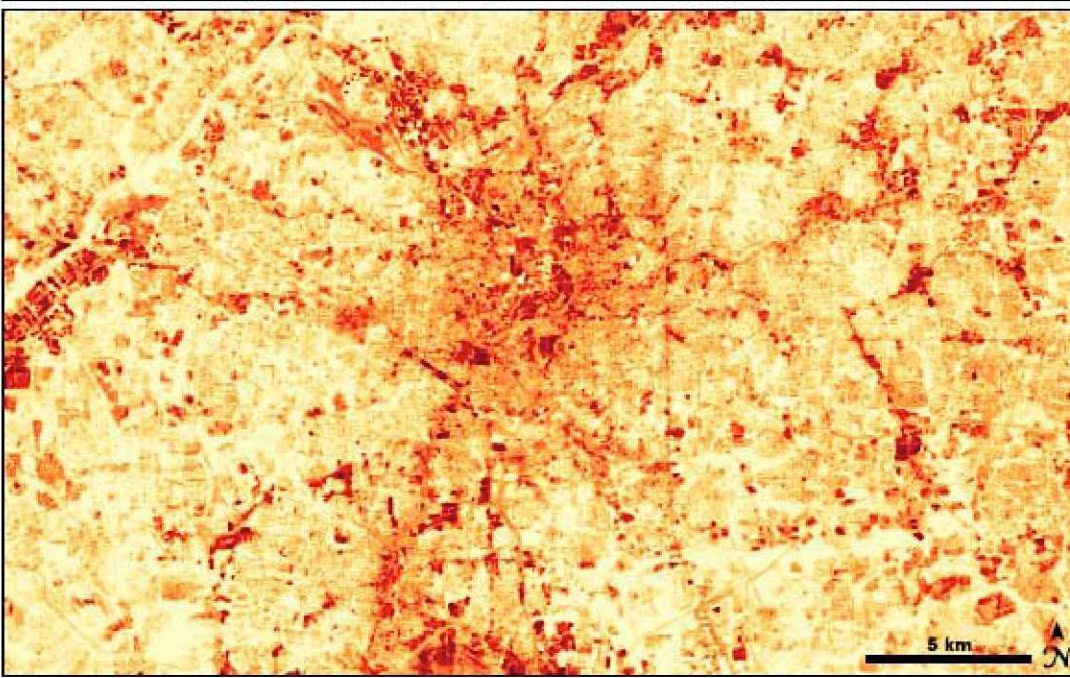
## Landsat Image of Istanbul



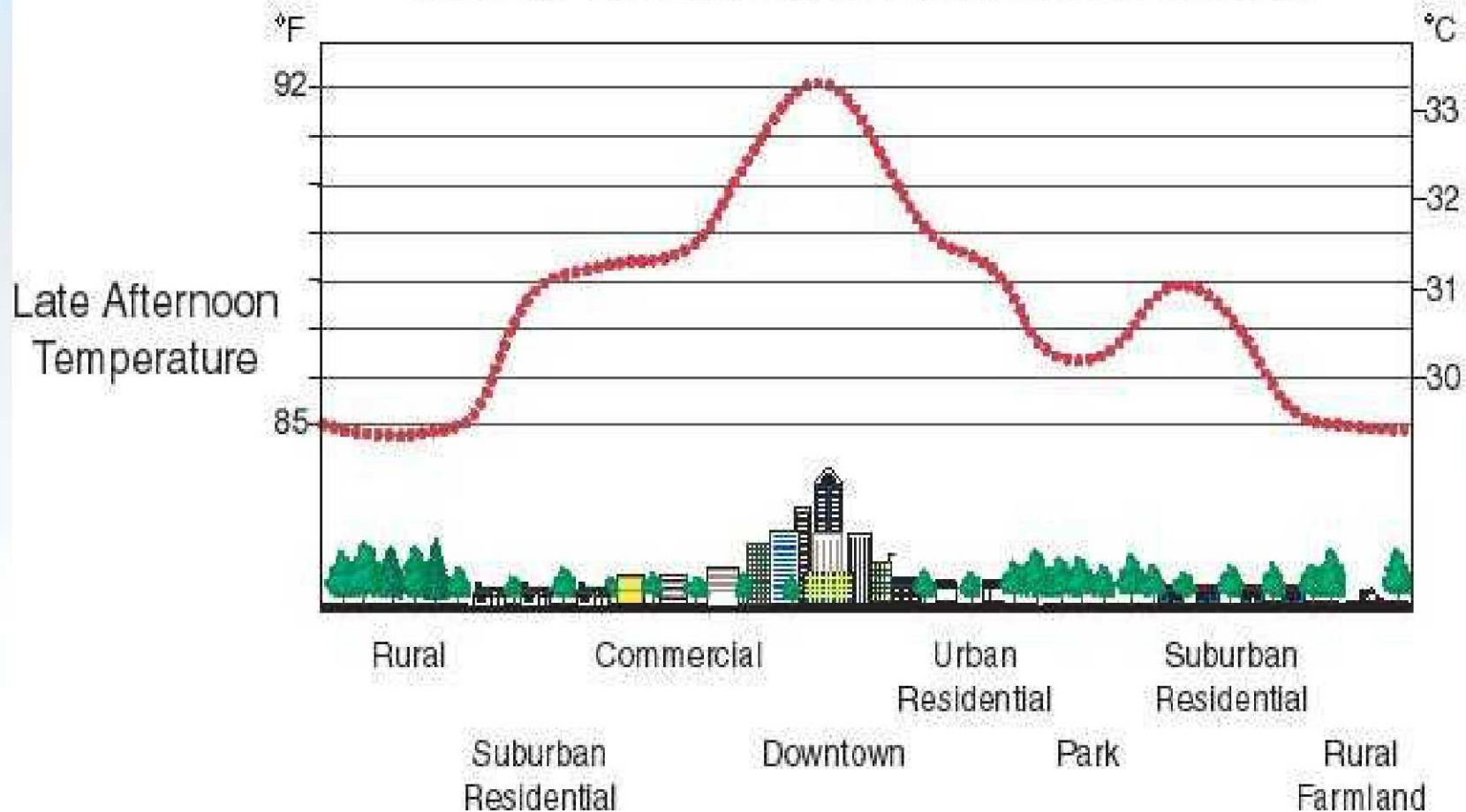




**Atlanta, GA  
and  
relationship of  
urban surface  
temperatures  
from Landsat  
data**



## Sketch of an Urban Heat-Island Profile







# Urban Climate: Local, Regional & Global Impacts

Mission to Planet Earth

National Aeronautics and Space Administration



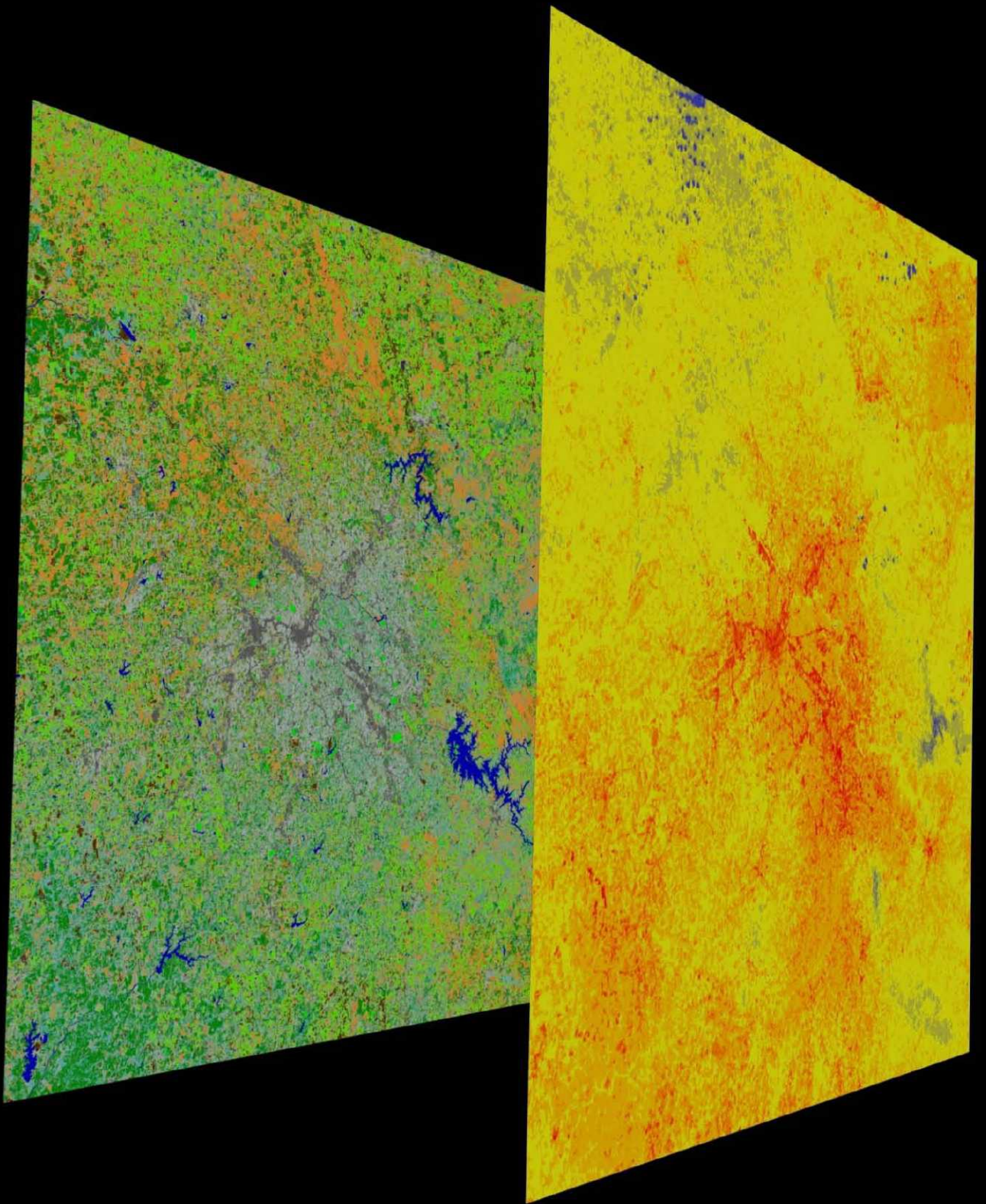
## Urban Remote Sensing and Air Quality Models

Volatile Organic Compounds  
+ Nitrogen Oxides  
+ Sunlight  
→ Ozone



- Air pollution remains a National issue.
- Temperature increases the ozone levels.
- Urban heat island has major effect on temperature and height of mixing layer.
- Measurement program is defining land use patterns and relationship to heat production.
- Remote sensing data are being used to improve air quality modeling.

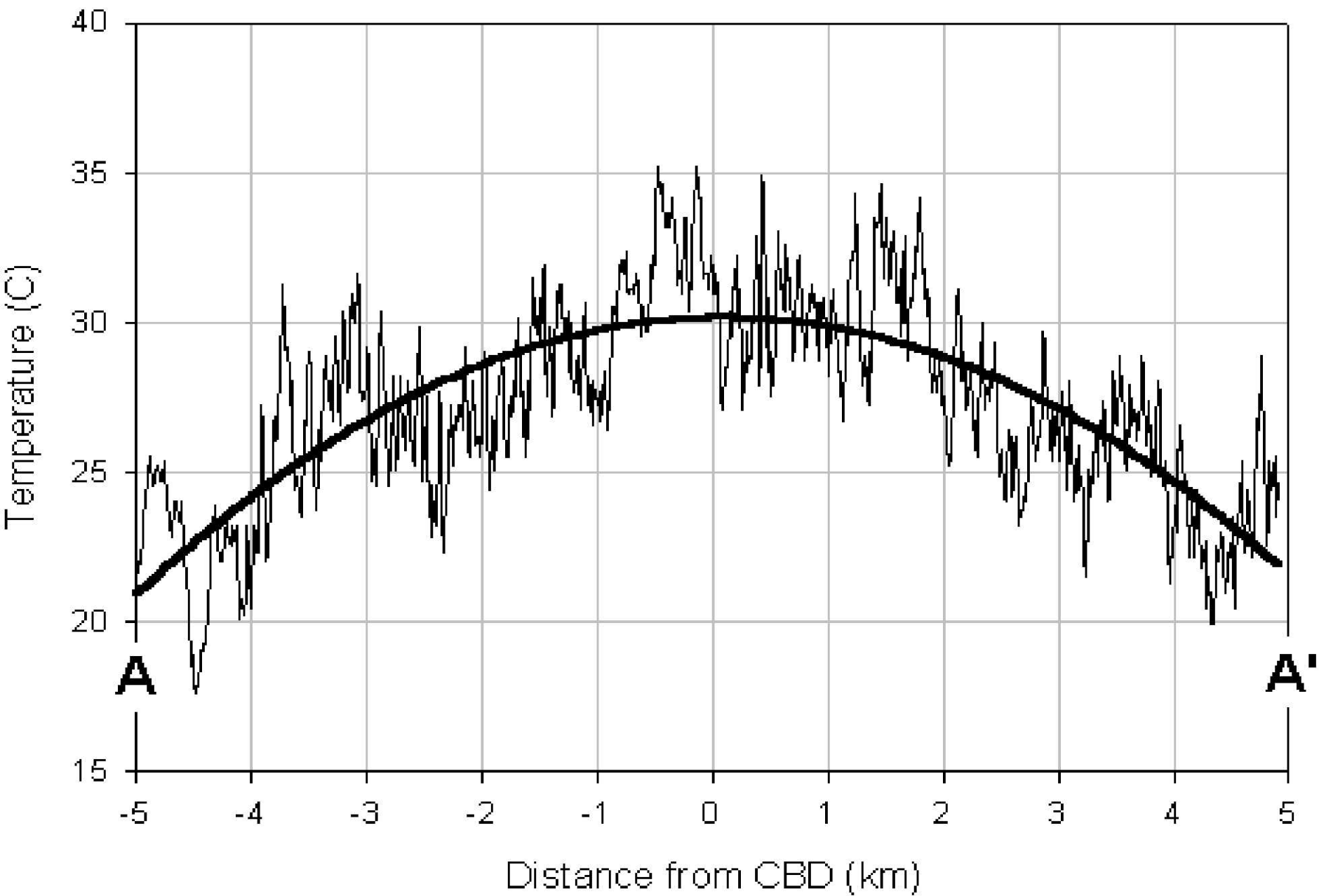












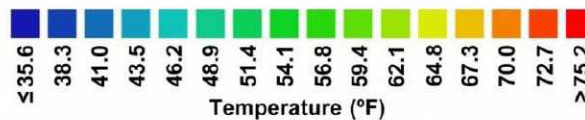
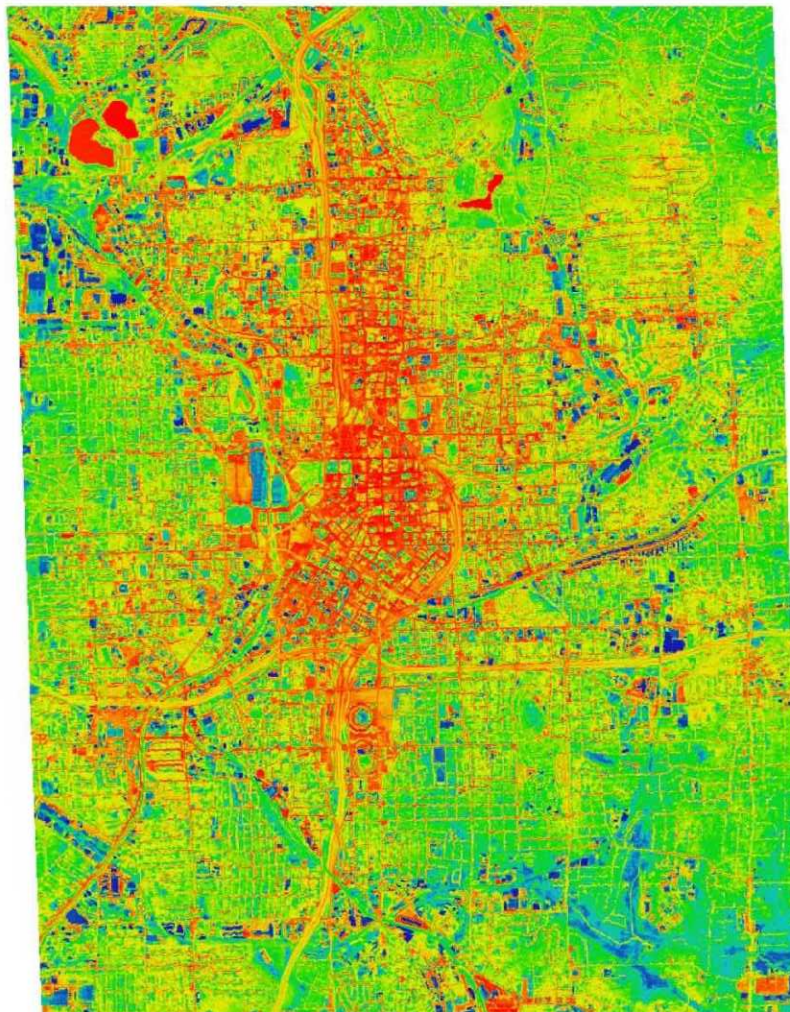








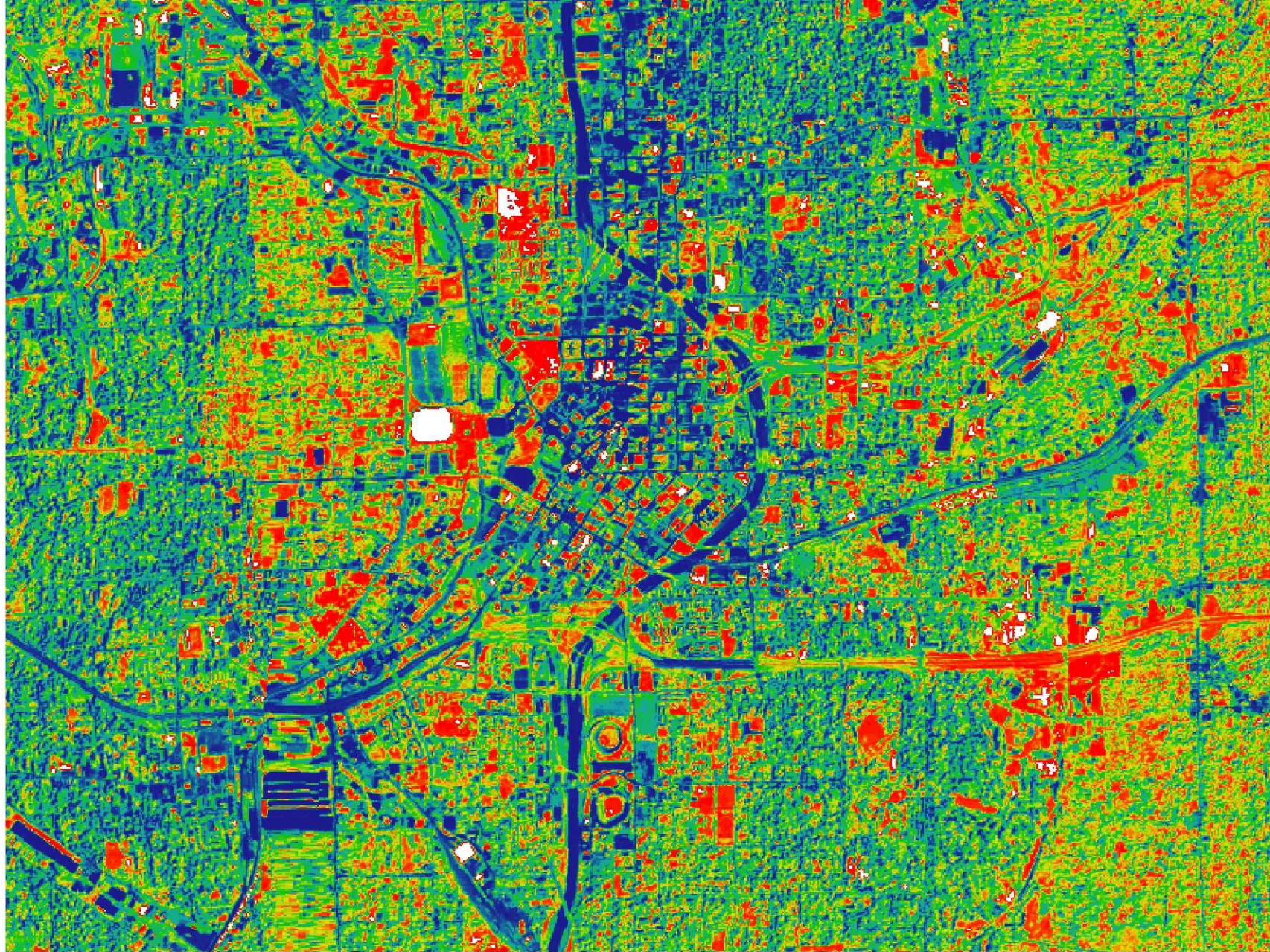
# Atlanta Central Business District Night Data – May 1997



Source: NASA / EPA







Albedo



$\leq 0.08$



0.14



0.20



0.26



0.32



0.38



0.44

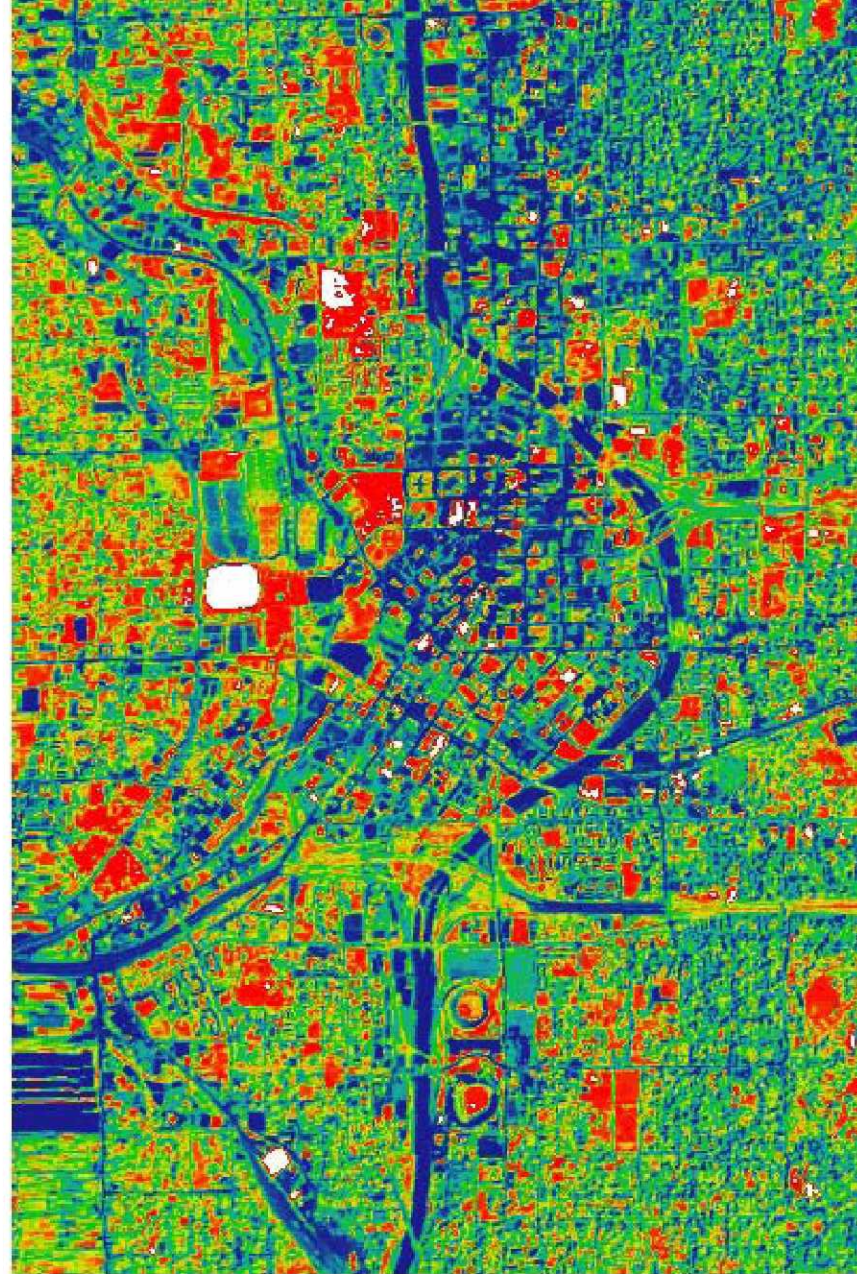


$\geq 0.50$





Temperature



Albedo

Atlanta, GA - May 1997



